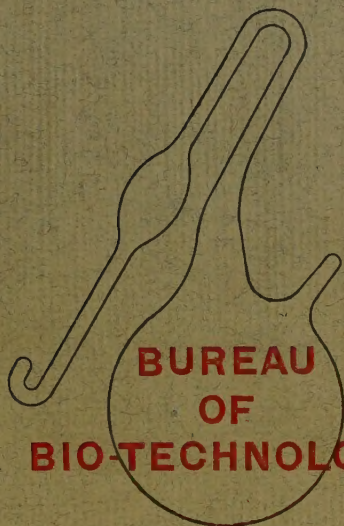

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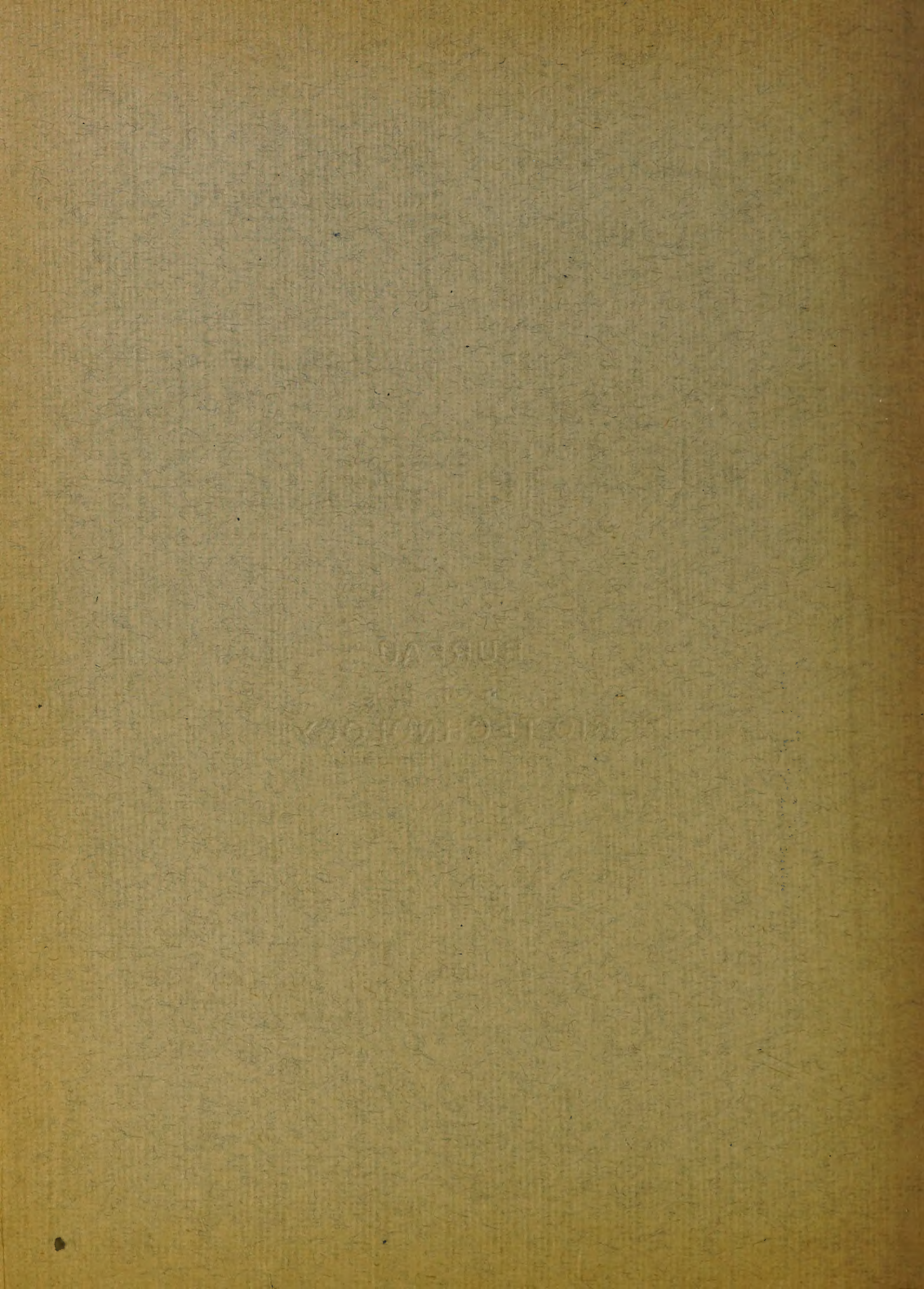
OCTOBER 1st, 1921



CONTRIBUTIONS FROM THE
BIOLOGICAL, CHEMICAL,
AND PHYSICAL RESEARCH
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BULLETIN No. 4

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FOREWORD

FORMER issues of the *Bulletin* have contained papers and notes arising out of the work of our Biological Laboratories only, but as research work is always in progress in our Physico-chemical department in London, and as much of that work is intimately related to biological problems, it is proposed, in future issues, to include notes from that department.

Our article in *Bulletin* No. 3, on "A Method of Determining Hydrogen Ion Concentration," has evoked a good deal of interest. Several enquiries have been received from technologists who wish to take advantage of Medalia's method, and express the desire to have some information with regard to the theory underlying its application. For some notes on this point (p. 105) we are indebted to Mr. N. K. Smitt, the head of our Physical Laboratory, and we believe that they will be of real value to those who wish to make use of the simple method outlined in *Bulletin* No. 3.

In the "Foreword" published in the same *Bulletin*, reference is made to the question of subscription. The demand for the *Bulletin* has very greatly increased since our first issue and the expense attached to its production has exceeded our expectations. Under present conditions, therefore, it will be necessary either to curtail its circulation or to charge a nominal subscription in order to cover a portion of the cost of production. The acknowledgment card accompanying the present issue provides for an expression of your willingness to be entered on our list as a subscriber.

October 1st, 1921.

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Micro-Organisms in the Leather Industries

2. SPECIES OF THE GENUS *PENICILLIUM* AND THEIR IDENTIFICATION.

IN a tabular arrangement of the fungi of leather technology published in *Bulletin* No. 3, June, 1921, no species of the blue and green moulds belonging to the genus *Penicillium* were included, for reasons stated. In this and a further paper it is proposed to discuss several organisms that in all probability have previously been referred to *Penicillium glaucum*, but which, thanks to the labours of S. Thom and Richard Westling, can be readily differentiated into separate species.

The micro-fungi belonging to this genus are perhaps the most ubiquitous organisms in the world. In the tannery, their "spores" may always be found in the atmosphere; the fungi themselves occur on raw skin, frequently cover the surface of tan liquors, and grow on finished leather. In other connections they are well known in cheese, on jam, on old boots, damp paper, rotting fruit, stale bread and decaying matter of all kinds. It is not very surprising that they were among the first microscopic fungi to attract attention after the introduction of the microscope as an aid to the study of natural objects. The first illustration of a

representative of this group was published in 1729, by Micheli, under the name *Aspergillus*, along with figures of other moulds which are still included in the genus *Aspergillus*. It was not until 1809, however, that Link, in his famous "Observations in Ordines Plantarum," recognised the distinguishing features of the two types of fungi and separated them under the generic names—*Penicillium* and *Aspergillus* respectively.

Since that date many species of *Penicillium* have been described, and at the present time something like 100 specific names are in existence. Of this number not more than half have been sufficiently accurately diagnosed to ensure recognition; some 20 more may represent distinct species which require further investigation, while the remainder are probably synonyms of the better-known species.

The species to be recorded as a result of the technical examination of leather and leather-making materials in this laboratory are as follows:—

Penicillium decumbens THOM,

P. expansum (LINK) THOM,

P. viridicatum WESTLING,

P. lanosum WESTLING,

together with minute white species so far unidentified, but which will be discussed in due course.

At this stage it may be pointed out that the data used for the differentiation of the above species of *Penicillium* is that of Richard Westling, as given in his Monograph, "Über die grünen Spezies der Gattung *Penicillium*," 1911. Various "keys" for the identification of species have been published. Wehmer's contribution to Lafar's "Technical Mycology" on the Morphology and subdivision of the family *Aspergillaceæ* (English edition, 1910, Vol. 2, p. 332) contains a brief summary of *Penicillium* species based on the colour of the "conidial herbage," but as the appearance

of surface growth varies with the medium employed, as well as with the age of the culture, it is of little value for practical purposes, as details on these points are omitted.

A "Key" to species of *Penicillium* from growths on agar and gelatine media, after Thom, is published in Harshberger's "Text Book of Mycology and Plant Pathology," 1918. This contains much more useful information than is given in the last-mentioned summary. It is particularly suggestive in its references to biological and bio-chemical points of difference, to which attention should be given during the culture and examination of *Penicillium* species, and the illustrations are a valuable feature of the key. On the other hand, the list of species is not nearly complete, and in the writer's experience, is not so satisfactory for purposes of reference as that of Westling's.

As the latter has been found of the greatest possible value in the routine work of this laboratory, and as it is not well known to English readers, a translation is appended. The term "conidial herbage" used in reference to surface growth is not a particularly happy English expression, but it is used in Lafar's "Technical Mycology," and is retained. It is very difficult for one observer to express in words, shades of colour that will be correctly interpreted by another, and Westling has made use of Klincksieck and Valette's "Code des Couleurs," in which the various colours are arranged numerically. Unfortunately this book is now out of print, and in order to facilitate reference to the Key by those who will be obliged to work without the "Code," the numbers have been transferred from their original position (in all cases following the colour of the conidial herbage) to the foot of each description.

The Key is based primarily on the separation of species into the two groups *Eupenicillium* and *Aspergilloides*: the latter group embraces species originally placed by Wehmer in the genus

Citromyces, but which both Thom and Westling regard as belonging to *Penicillium*. The accompanying diagram will illustrate the two types and will at the same time serve to introduce the term

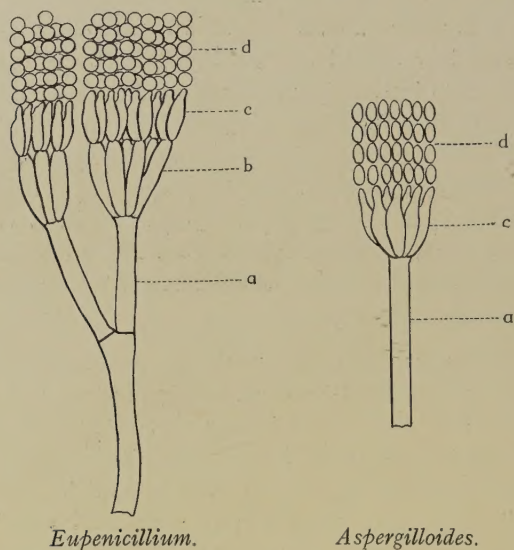


FIG. 4.—DIAGRAM ILLUSTRATING WESTLING'S TYPES.
a, conidiophore; b, metulæ; c, sterigmata; d, conidia.

"*metulæ*," of which Westling makes valuable diagnostic use and which does not figure in any of the text-books on Mycology.

F. A. MASON.

(TO BE CONTINUED.)

CORRECTION: For "*Uromyces glumarum*" on page 71, line 14.
Bulletin No. 3, read "*Puccinia glumarum*."

KEY TO
THE GREEN SPECIES OF *PENICILLIUM*.*

I. MORPHOLOGICALLY WELL-MARKED SPECIES.

× Sect. **EUPENICILLIUM**. Conidiophores septate, apex penicillately branched (*Penicillium glaucum* type).

A. Conidia large (5μ long or longer).

1. Conidia spherical—elliptical.

a. Conidial herbage blue-green, later dark green; conidiophores smooth or delicately warted, $4-6.5\mu$; metulæ $4-6.5\mu \times 14-20\mu$; sterigmata $3-3.6\mu \times 10.5-15\mu$; conidia $4.7-5.6 \times 4.8-5.8\mu$.
(Kl. 353, 358 later 334, 339)

P. majusculum WESTLING. ✓

2. Conidia elliptical—elongate.

a. Conidial herbage olive to yellowish green; conidiophores smooth, $4.7-7.5\mu$; metulæ $6-8\mu \times 14-20\mu$; sterigmata $3-5.2\mu \times 12-20\mu$; conidia $3.5-5\mu \times 4.7-8\mu$.

(Kl. 297 then 293)

P. digitatum SACC. ✓

(*P. olivaceum* WEHMER.)

B. Conidia medium size ($4-4.8\mu$ long).

1. Conidia spherical, or nearly so.

a. Conidial herbage pale blue-green, then darker, underside yellowish; conidiophores smooth or to a small extent delicately warted, $3.6-4.6\mu$; metulæ $3.4-4.8\mu \times 11-16\mu$; sterigmata $2.5-3.2\mu \times 8-10\mu$; conidia $3.8-4.6\mu$.

(Kl. 353, 358 then 363—364)

P. roqueforti THOM. ✓

*RICH. WESTLING—*Über die grünen Spezies der Gattung Penicillium*, Arkiv för Botanik, Stockholm, 1911.

- b. As above except that the underside later becomes dark green to almost black.

P. roqueforti THOM var. *Weidemannii* WESTLING. ?

- c. Conidial herbage deep green, becoming darker; conidiophores smooth—nearly smooth, $4-6\mu$; metulæ $3.4-4.8\mu \times 12-16\mu$; sterigmata $3.2-3.4\mu \times 8-9.6\mu$; conidia $4-4.6\mu$.

(Kl. 329, later 334, 339)

P. conditaneum WESTLING. anew 10
sk

- d. Conidial herbage pale blue-green, then darker; conidiophores smooth or minutely warted, $4-6.4\mu$; metulæ $3.6-5\mu \times 12-16\mu$; sterigmata $3-3.4\mu \times 8-9.6\mu$; conidia $3.8-4.6\mu$.

(Kl. 367, 362, then 363, 334 later 334, 338, 340)

P. solitum WESTLING. ✓

- e. Conidial herbage woolly, white, later bluish or greenish; conidiophores smooth, $4-5\mu$; metulæ $4-4.5\mu \times 12-16\mu$; sterigmata $2.6-3.2\mu \times 9-11.4\mu$; conidia $4.2-5\mu$.

P. camemberti THOM. ✓

- f. Conidial herbage at first bright green, later olive green or blue-green; conidiophores rough or slightly warted, occasionally smooth, $4.2-6.4\mu$; metulæ $4-6\mu \times 12-18\mu$; sterigmata $3-3.6\mu \times 7.5-11.5\mu$; conidia $3.8-4.4\mu$.

(Kl. 347, 293, 297-293, 268, 347-342)

P. bifforme THOM. ✓

2. Conidia elliptical—elongate.

- a. Conidial herbage pale greenish-blue; underside frequently brown; conidiophores smooth, $4-6.6\mu$; metulæ $4-6.5\mu \times 14-20\mu$; sterigmata $3.2-3.5\mu \times 9-12\mu$; conidia $3.2-4\mu \times 4-5.5\mu$.

P. italicum WEHMER. ✓

- b. Conidial herbage at first light green, later dark green; conidiophores smooth or delicately warted, $4.4-6.6\mu$; metulæ $4-6.5\mu \times 12-16\mu$; sterigmata $3.2-4\mu \times 9-11.6\mu$; conidia at first spherical, later elliptical—elongate, $3.6-4.3\mu \times 4-4.7\mu$.

(Kl. 333, 313 then 309, 314)

P. palitans WESTLING. ✓

- c. Conidial herbage bluish-green; conidiophores smooth, $3.4-5.6\mu$; metulæ $4-6.4\mu \times 10-14\mu$; sterigmata $3.2-3.4\mu \times 6.5-9\mu$; conidia $3-3.6\mu \times 3.8-4.6\mu$; Perithecia yellow, egg-shaped to oval, $0.1-0.25$ mm.; ascospores $4.2-4.8\mu \times 5.2-6\mu$.

(Kl. 358—353, 363)

P. baculatum WESTLING.

- d. Coremia club-shaped, frequently branched, bluish-green, 1—2 cm. high; it occurs more rarely as isolated conidiophores, smooth, $3.3-4.6\mu$ in diameter; metulæ $4-7.6\mu \times 12-16\mu$; sterigmata $1.8\mu-2.8\mu \times 7.5-10.5\mu$; conidia $3-3.3\mu \times 4-4.6\mu$.

(Kl. 362 then 363)

P. claviforme BAINIER.

C. Conidia small (about $3-4\mu$ in length).

1. Conidia spherical or nearly so.

- a. Conidial herbage pale green; conidiophores smooth, $4.4-6.5\mu$; metulæ $4-5.6\mu \times 10-12\mu$; sterigmata $3.2-3.4\mu \times 8-9.6\mu$; conidia $3-3.8\mu$.

(Kl. at first 371, later 338, 304, then 309)

P. viridicatum WESTLING.

2. Conidia elliptical—elongate.

- a. Conidial herbage at first bluish-green, then distinctly blue-green, woolly; underside yellowish-brown;

conidiophores smooth, $3.6\text{--}4.8\ \mu$; metulæ $3.6\text{--}4.5\ \mu \times 12\text{--}18\ \mu$; sterigmata $2.6\text{--}3\ \mu \times 7.5\text{--}10\ \mu$; conidia $2.6\text{--}3.2\ \mu \times 3\text{--}3.8\ \mu$. Occasional small coremia produced.

(Kl. 367 then 367—363, 368, 398)

P. expansum (LINK) THOM. ✓

- b. As above, but underside white or slightly yellow, coremia never produced.

P. commune THOM. ✓

- c. Conidial herbage dark bluish-green; conidiophores smooth, $3\text{--}4.5\ \mu$; metulæ $2.6\text{--}4.2\ \mu \times 10\text{--}18\ \mu$; sterigmata $2.2\text{--}3\ \mu \times 7.5\text{--}10\ \mu$; conidia $2.6\text{--}3\ \mu \times 3.2\text{--}4\ \mu$.

(Kl. 353, 358, later 363)

P. atramentosum THOM.

- d. Conidial herbage bluish-green; conidiophores smooth or delicately warted, $3\text{--}4.8\ \mu$; metulæ $3\text{--}4.4\ \mu \times 8\text{--}14\ \mu$; sterigmata $2\text{--}2.8\ \mu \times 7\text{--}10.5\ \mu$; conidia $2.4\text{--}3.2\ \mu \times 3\text{--}3.8\ \mu$.

(Kl. 358—383, 358, later 393, 363)

P. chrysogenum THOM. ✓

- e. Conidial herbage green, underside red; conidiophores smooth, $3\text{--}4.6\ \mu$; metulæ $2.5\text{--}4\ \mu \times 9\text{--}12\ \mu$; sterigmata $1.6\text{--}2.6\ \mu \times 9\text{--}12\ \mu$; conidia $2\text{--}2.8\ \mu \times 2.8\text{--}3.8\ \mu$; abundant coremia.

(Kl. 329, 338, then 343)

P. Duclauxi DELACROIX. ✓

- f. Conidial herbage first pale blue and then later greenish-blue; conidiophores smooth, $3.2\text{--}5\ \mu$; metulæ $3.6\text{--}4.8\ \mu \times 10.5\text{--}14\ \mu$; sterigmata $2.6\text{--}3\ \mu \times 8\text{--}9\ \mu$; conidia $2.8\text{--}3.4\ \mu \times 3.4\text{--}4.2\ \mu$.

(Kl. 422, 392—387, later 383 and then 388)

P. piscarium WESTLING.

- g. Conidial herbage at first pale grey, later greenish; conidiophores smooth, very little branched or quite

simple, $3-4.5\mu$; metulæ $2.8-4\mu \times 12-20\mu$ or 0; sterigmata $2-2.6\mu \times 8-9.6\mu$; conidia $2.2-2.8\mu \times 3-3.5\mu$; with sterile Perithecia.

(Kl. 347, 272, 372)

P. turbatum WESTLING.

h. Conidial herbage bright green; conidiaphores smooth, $3-4.6\mu$; metulæ $3-4.5\mu \times 10-18\mu$; sterigmata $1.8-2.6\mu \times 7.5-10\mu$; conidia $2-2.8\mu \times 2.7-3.8\mu$.

(Kl. 342, 346 then 347, 347-342)

P. Lagerheimi WESTLING.

i. Conidial herbage at first bluish-green, later dark dirty green; conidiaphores smooth, $3-3.8\mu$; metulæ $2.2-3.8\mu \times 10-15\mu$; sterigmata $2-2.7\mu \times 9-10.5\mu$; conidia $2.3-3\mu \times 2.8-3.4\mu$.

(Kl. 378B, 343, 318, later 319, 320)

P. rugulosum THOM.

k. Conidial herbage at first reddish, then green, underside blood-red; conidiaphores $2.7-3.4\mu$; metulæ $2.6-3\mu \times 7-14\mu$; sterigmata $1.5-2.2\mu \times 10.5-12\mu$; conidia $1.4-2\mu \times 2.8-3.4\mu$.

(Kl. 373)

P. pinophilum HEDGCOCK.

D. Conidia minute (up to 3μ in diameter).

1. Conidia spherical—or nearly so.

a. Conidial herbage dark green, underside orange to red; conidiaphores smooth, $3-4.5\mu$; metulæ $2.4-3.6\mu \times 9-12\mu$; sterigmata $1.8-2.5\mu \times 9-10\mu$; conidia $2.2-2.5\mu$.

P. rubrum (GRASSBERGER) STOLL.

b. Conidial herbage woolly, pale bluish-green then greyish-green; conidiaphores smooth, $3.4-4.6\mu$;

metulae $3-4.6\mu \times 12-14\mu$; sterigmata $2-2.7\mu \times 7.5-9\mu$; conidia $2.2-3\mu$.

(Kl. 347 then 323, 372, 318, later 343)

P. lanosum WESTLING. ✓

- c. Conidial herbage pale green, later dark bluish-green; conidiophores smooth, $2.8-4.6\mu$; metulae $3-4.5\mu \times 10.5-14\mu$; sterigmata $2.2-3\mu \times 7-8\mu$; conidia $2.6-3.2\mu$.

(Kl. 396, 397 later 383—388, 388, then 393)

P. notatum WESTLING. ✓

- d. Conidial herbage pale blue-green, later dull green; conidiophores warted, occasionally smooth, $3.2-5\mu$; metulae $3.2-4.5\mu \times 9.5-14\mu$; sterigmata $2.2-2.8\mu \times 8-9\mu$; conidia $2.6-3.2\mu$.

(Kl. 367, 367—362, later 338 then 363)

P. cyclopium WESTLING. ✓

- e. Conidial herbage at first pale bluish-green, later dark-blue green; conidiophores delicately warted, occasionally smooth, $4.2-6\mu$; metulae $3.2-4.6\mu \times 11.4-16\mu$; sterigmata $2.4-3\mu \times 8-9.6\mu$; conidia $2.6-3.2\mu$; coremia produced abundantly.

(Kl. 353, 358, 358—363)

P. corymbiferum WESTLING. ✓

- f. Conidial herbage bluish-green, green and finally yellowish-green; conidiophores smooth, $3.8-6\mu$; metulae $3.2-6\mu \times 11.4-15\mu$; sterigmata $1.6-2.5\mu \times 7.5-9\mu$; conidia frequently oval at first and then spherical.

(Kl. 353, later 338, 317—313 then 284, 285, 289)

P. tabescens WESTLING.

- g. Conidial herbage pale greyish-green; conidiophores smooth, $2-3.8\mu$; simple, or penicillately branched; metulae $2.3-3.6\mu \times 10-15\mu$ or 0; sterigmata

1.6—2.6 μ $\times$ 7—9 μ ; conidia 2.2—3 μ ; underside yellow.

(Kl. 347)

P. citrinum THOM.

2. Conidia elliptical—elongate.

- a. Conidial herbage pale blue-green, later darker; conidiophores 4—6.5 μ ; metulæ 3—4.6 μ $\times$ 11—14 μ ; sterigmata 1.6—2.3 μ $\times$ 7.5—9 μ ; conidia 1.8—2.6 μ $\times$ 2.4—3.2 μ ; metulæ and sterigmata delicately warted; abundant coremia.

(Kl. 367, later 363—338)

P. granulatum BAINIER.

- b. Submerged mycelium yellowish to intensely yellow; conidial herbage dark green, underside orange; conidiophores smooth, 2.8—3.6 μ ; metulæ 2.6—4 μ $\times$ 9—12 μ ; sterigmata 2.2—2.8 μ $\times$ 8—12 μ ; conidia 1.6—2.4 μ $\times$ 2.4—2.8 μ ; perithecia yellow, spherical, 1—2 mm. in diameter; ascospores 2.8—3 μ $\times$ 4—5 μ , furnished with delicate transverse bands.

(Kl. 335, 339, 340)

P. luteum ZUKAL. ✓

- c. Conidial herbage at first pale greyish-green, eventually overgrown with whitish, and finally reddish aerial mycelia; conidiophores smooth, 2.5—3.8 μ ; metulæ 2.6—3.8 μ $\times$ 9—14 μ ; sterigmata 2—2.6 μ $\times$ 10—12 μ ; conidia 1.5—2 μ $\times$ 2.2—3 μ .

(Kl. 347, then 363, 363—343, 338, 372—343)

P. africanum DOEBELT.

- d. Conidial herbage at first pale greyish-green, later darker; conidiophores smooth, 3.2—4 μ ; metulæ 2.8—4 μ $\times$ 10.5—15 μ ; sterigmata 1.8—2.6 μ $\times$ 9—12 μ ; conidia 1.6—2.4 μ $\times$ 2.6—3.2 μ .

(Kl. 347—367, later 343, 348—343)

P. purpurogenum (FLEROFF) STOLL. ✓

- e. Conidial herbage at first pale greyish-green, then darker ; conidiophores smooth, $2.6-3.8 \mu$; metulæ $2.2-3.4 \mu \times 12-18 \mu$; sterigmata $1.6-2.2 \mu \times 9-12 \mu$; conidia $1.6-2.3 \mu \times 2.3-3 \mu$.

(Kl. 347, then 347—348, 348)

P. funiculosum THOM.

- f. Conidial herbage greenish-blue, later blue-green ; conidiophores smooth, $4.2-6 \mu$; metulæ $3-6 \mu \times 10.5-15 \mu$; sterigmata $1.6-2.3 \mu \times 7.5-9 \mu$; conidia $2.4-2.8 \mu \times 2.7-3.2 \mu$.

(Kl. 387, later 363, 368)

P. stoloniferum THOM.

- g. Conidial herbage pale greyish-green ; conidiophores smooth, $3.2-4.8 \mu$; metulæ $3.2-4.8 \mu \times 12-16 \mu$; sterigmata $2.4-3 \mu \times 7-9.6 \mu$; conidia $2.2-2.7 \mu \times 2.8-3 \mu$.

(Kl. 347 later 347—322, 347—372, 372)

P. ventruosum WESTLING.

× × Sect. **ASPERGILLOIDES** (Wehmer's genus *Citromyces*). Conidiophores septate and unbranched at the apex (as distinct from *Penicillium glaucum* type). The sterigmata are attached directly to the more or less swollen tips of the conidiophores.

- a. Conidial herbage at first pale bluish-green, then darker and finally dark green ; conidiophores smooth, $2.2-3.4 \mu$; sterigmata $2.2-3 \mu \times 7.5-11.5 \mu$; conidia smooth or delicately warted, spherical $3-3.8 \mu$.

(Kl. 367 later 358—363, 335, 339, then 310, 315)

P. spinulosum THOM.

- b. Conidial herbage smooth, velvety, pale greyish-green, and then darker ; conidiophores smooth,

2.6—3.4 μ ; sterigmata 2—2.8 $\mu \times$ 7.5—11.6 μ ;
conidia spherical, smooth, 2.5—3 μ .

(Kl. 347—348, later 348, 343—348)

P. glabrum (WEHMER) WESTLING.

(*Citromyces glaber* WEHMER.)

- c. Like *P. glabrum*, but the conidial herbage woolly or thread-like, downy, not velvety.

P. pfefferianum (WEHMER) WESTLING.

(*Citromyces pfefferianus* WEHMER.)

- d. Conidial herbage at first bluish, then dark blue-green and finally dark green or olive green; conidiophores smooth, 2.2—3.2 μ ; sterigmata 2.2—3.2 $\mu \times$ 8—11.5 μ ; conidia small, spherical, smooth—rarely warted 2.6—3 μ .

(Kl. 403, later 367—397, then 363, 363—368,
finally 319, 313, 305, or 289, 290)

P. frequentens WESTLING.

- e. Conidial herbage greenish-grey; conidiophores smooth, 1.6—3.6 μ ; sterigmata 1.5—2.7 $\mu \times$ 7.5—10.5 μ ; conidia spherical or occasionally oval, smooth, 2.3—3 μ or 1.6—2.8 $\mu \times$ 2.4—3 μ .

(Lighter than Kl. 372)

P. decumbens THOM.

- f. Conidial herbage pale bluish-grey, darkening with age; conidiophores smooth, 2.2—3.5 μ ; sterigmata 2—2.4 $\mu \times$ 9—12 μ ; conidia small, oval or egg-shaped, smooth or uneven, 2.2—2.6 $\mu \times$ 2.7—3.2 μ .

(Kl. 422, later 423, 393—398, 398)

P. lividum WESTLING.

- g. Conidial herbage light greyish-green and then darker; conidiophores smooth 2.6—3.4 μ ; sterigmata 2.3—3 $\mu \times$ 7.5—11.5 μ ; conidia small, smooth, oval or slightly elongated, 2—2.4 $\mu \times$ 2.3—3 μ .

(Kl. 347, 347—372, later 372—373, 373, 322)

P. subcinereum WESTLING.

INSUFFICIENTLY DESCRIBED, BUT PROBABLY GOOD SPECIES.

× Sect. **EUPENICILLIUM.**

A. Conidia medium size, $4-5\mu$ long.

- a. Conidial herbage blue, then bluish-green, afterwards dirty green; conidiophores warted; conidia spherical 4.2μ .

P. asperulum BAINIER.

- b. Like *P. asperulum*, but conidiophores quite smooth—occasionally minutely warted; conidia spherical, 4.2μ .

P. puberulum BAINIER.

B. Conidia about $3-4\mu$ long.

- a. Conidial herbage blue-green, then dark green, not zoned; conidiophores $2.4-3.5\mu$; metulæ $3.5-10-12\mu$; sterigmata 10μ ; conidia spherical, $3-3.3\mu \times 3.3-3.8\mu$; yellow sclerotia, 0.5 mm. diam.

P. kiliense WEIDEMANN.

- b. Conidial herbage pale green, finally dirty green; metulæ frequently absent; sterigmata 7μ ; conidia spherical, 3.7μ ; cells frequently with bladder-like expansions.

P. vesiculosum BAINIER.

C. Conidia minute, up to 3μ .

1. Conidia spherical or slightly oval.

- a. Conidial herbage blue-green; conidiophores slender (about 2.8μ), sparingly branched; sterigmata 8.4μ ; conidia 2.8μ .

P. faxilli BAINIER and *P. patulum* BAINIER.

- b. Conidial herbage green, pulverulent; sterigmata 8.4μ ; conidia 2.8μ .

P. virescens BAINIER.

- c. Conidial herbage greyish-blue; sterigmata up to 19μ ; conidia 2.8μ .

P. erectum BAINIER.

- d. Conidial herbage greenish to vivid green; sterigmata $8-9\mu$; conidia 2.8μ .

P. urticæ BAINIER.

- e. Conidial herbage greenish-grey, zoned with sterile yellow hyphæ; conidiophores 2.3μ ; conidia 2.3μ .

P. bicolor OUD.

2. Conidia elliptical—elongate.

- a. Conidial herbage yellowish-green to olive green; conidiophores $3-3.2\mu$; conidia $2-2.3\mu \times 2.2-2.8\mu$.

P. musæ WEIDEMANN.

- b. Conidial herbage pale green, then darker; finally grey-green, granular; conidiophores $3-3.5\mu$; sterigmata $2.5-3\mu \times 12\mu$; conidia $2.3\mu-2.7\mu$.

P. juglandis WEIDEMANN.

- c. Conidial herbage bluish to distinctly blue; finally dirty green; conidia $1.4-1.6\mu$.

P. elongatum BAINIER.

× × Sect. **ASPERGILLOIDES.**

- a. Conidial herbage green; hyphæ $2.8-5.6\mu$; conidia round.

P. aspergilliforme BAINIER.

A Laboratory Note on the Control of *Trogoderma khapra*.

DURING the past nine months a considerable amount of information has been collected concerning the distribution of the pest throughout this country as well as the amount of damage evident in maltheuses.

There seem to be indications that the pest is gradually spreading, and undoubtedly once it has become firmly established in a maltheuse, drastic treatment is necessary to keep it under control.

To exterminate *T. khapra* completely, repeated fumigations in conjunction with direct treatment of the infected structure is the only means available. As a result of this information, a large amount of experimental work has been carried out in order to find a really effective fumigant which can be used in the bins while the malt is still contained therein.

The experimental work has included the use of a number of volatile organic compounds, comprising Carbon-tetrachloride, Trichlorethylene, Tetrachlorethane, Pentachlorethane and Chloropicrin.

METHOD.—The apparatus used for fumigating consisted of a large glass vessel of $27\frac{1}{2}$ litres, or approx. 1 cu. ft. capacity. Into the neck of the vessel a two-holed rubber bung was inserted, carrying a tube for admitting the solvent and a glass hook upon which was suspended a perforated metal dish to hold the *T. khapra* larvæ.

These larvæ were first introduced into the metal dish, the bung inserted, and the material under investigation admitted down the delivery tube by means of a finely-graduated pipette.

The whole apparatus now being hermetically sealed, the vapours were allowed to act for 1,000 minutes (16 hours 40 minutes). When each fumigation was completed, the larvæ were removed from the dish and left exposed to the air for some days, in order to observe whether the insects recovered from the effects of the vapour.

The experiments were conducted as far as possible at room temperature, which ranged from 45°F to 60°F.

Compounds Used.	Number of Fumigations with each Compound.	Strength of Compound Used.	Time of Exposure of Larvæ to Vapours.	Mortality (after four days in air).
Carbon-tetrachloride	3	10 ozs. to 1,000 cu. ft.	1,000 mins.	11·0%
Tetrachlorethane .	3	”	”	73·3%
Pentachlorethane .	3	”	”	77·7%
Trichlorethylene .	3	”	”	27·7%
Chloropicrin] . .	2	”	”	100·0%

From the above experiments it was concluded that pentachlorethane was the most satisfactory. Consequently a series of experiments were conducted to determine if this material produced any deleterious effects upon the malt or flavoured the beer ultimately prepared from such treated malt.

A mass of fresh malt was placed in a chamber of known capacity and sprinkled with pentachlorethane at the rate of 1 pint to the 1,000 cu. ft.

The chamber was completely sealed up and the vapours allowed to act for 1,000 minutes. The malt was then removed, and the odour and taste of the compound used were clearly apparent.

These were, however, dispelled to a very considerable extent after re-drying (kilning). It was observed that the kilned malt lost all smell of the pentachlorethane after exposure to air for two days.

A mash was next prepared, using (1) Distilled water and (2) Tap water. The mashing operation proceeded quite normally, and the final wort gave normal figures for Extract, etc. There was, however, yet a slight taste of the fumigant left in the wort.

This was next boiled for thirty minutes, but no hops were added. After boiling, the worts were tasted and it was found that no traces whatever of the original fumigant could be detected.

Fermentations were next set up, and these proceeded in a normal manner, primary fermentation being finished in the usual time. The samples were bottled and placed on the forcing tray for future observation.

The following conclusions have been deduced from the experiments carried out:—

- (1) That Pentachlorethane can be successfully used for killing "free" larvæ in the bins. The fumigant does not kill those insects living in the interior of the grain.
- (2) That Chloropicrin is more effective for killing the larvæ, but it is far more unpleasant to use, and further experiments must be carried out to determine its effect upon malt.
- (3) This substance (Chloropicrin) has been used quite successfully for destroying weevil in barley, but it does certainly affect the germinating powers of the barley.
- (4) That the majority of the Pentachlorethane may be removed from treated malt by thoroughly re-drying on the kiln during which the malt is repeatedly turned.
- (5) That any remaining traces of the material are finally dispelled when the wort is boiled in the open coppers, and that no deleterious effect is produced upon the ultimate taste of fermented liquors.

T. PARKER AND A. W. LONG.

Note on Medalia's Method of Determining Hydrogen Ion Concentration.

MEDALIA'S method, described in the last issue of the *Bulletin*, ⁽¹⁾ is based on the same principles as Gillespie's method ⁽²⁾, but certain simplifications are introduced, which render the procedure more convenient for routine purposes. In both cases use is made of the fact that the percentage colour transformation of an indicator in solution depends on the H.I.C. of that solution, *i.e.*, for any particular value of pH a definite amount of the indicator is in the acid form and a definite amount in the alkaline form.

The modern theory of indicators is based on a modification of Ostwald's older ionic theory, and the colour change is considered to be associated with tautomeric change of the indicator and with dissociation of the stable tautomer ⁽³⁾. If the law of mass action be applied to the tautomeric equilibria in a solution of an indicator which acts, for instance, as a monobasic acid, it is evident that

$$C_a = K_1 \times C_b,$$

where C_a and C_b are the concentrations of the acid and alkaline tautomeric forms, and K_1 is a constant. Considering similarly the dissociation equilibria, we obtain

$$C_c \times C_H = K_2 \times C_a$$

where C_c , C_H and C_a are respectively the concentrations of the negatively charged ions, hydrogen ions and undissociated molecules

of the acid form, and K_2 is the ionisation constant of the dilution law. By combining these two equations and putting the result in logarithmic form, we obtain

$$\text{pH} = K + \log \frac{\text{concentration of alkaline form}}{\text{concentration of acid form}}$$

where K is the apparent dissociation constant of the indicator. The ratio of the concentrations of the alkaline and acid forms is the "drop-ratio" of the previously described method ⁽²⁾. The problem is then to determine the percentage colour transformation of the indicator in a given solution, the percentage transformation being assumed to be related to the pH of the solution by the dissociation curve of the particular indicator. The separation of the two forms of the indicator, for this purpose, is explained in the following quotation from Gillespie's paper ⁽²⁾:

"We may assume that light is absorbed independently by the two forms of the indicator, and hence that the absorption, and in consequence of this the residual colour emerging, will be the same whether the two forms are present together in the same solution or whether the forms are separated for convenience in two different vessels and the light passes through one vessel after the other. Therefore if we know what these percentages are for a given indicator in a given buffer mixture we can imitate the colour shown in the buffer mixture by dividing the indicator in the proper proportion between two vessels, and putting part of it into the acid form with excess of acid, and the rest into the alkaline form with excess of alkali."

The suitability of an indicator for this method must be determined experimentally. Thus a dibasic indicator may be used, if its two dissociation constants are separated by a sufficiently wide range of pH. Curves co-relating the drop ratio and pH can then be constructed from experimental data and from the equation $\text{pH} = K + \log (\text{drop ratio})$, and tables drawn up.

Medalia's tables, however, are based upon experimental data which have not been corrected by the application of the mass action equation, but though they have been criticised by Gillespie⁽⁴⁾, they are, as was stated in the earlier article, capable of giving "relatively accurate data by simple means."

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- (2) Gillespie, L. J., *Soil Science*, Vol. 9, 115.
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N. K. SMITT.

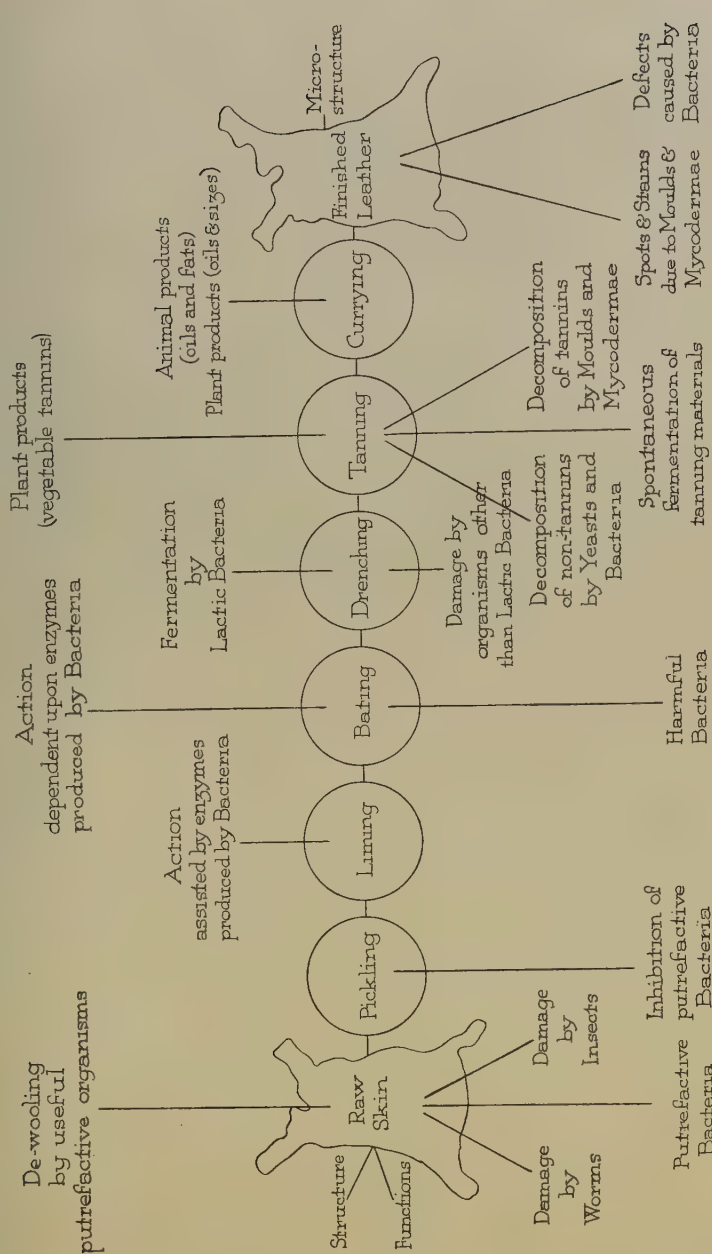
Notes and Comments

The *Leather Trades' Year Book* for 1921, edited by Dr. J. Gordon Parker, contains a paper on "Biology in its relationship to the Leather Industry," written by the Director of our Biological Department. It is illustrated with photo-micrographs and other photographs, and includes a Chart showing the biological factors which enter into the various processes of leather manufacture. We are indebted to the editor of the *Year Book* for permission to reproduce this Chart (see opposite page).

Among the many biological features touched upon, the writer refers to the question of damage to hides by the Warble Fly, and it is gratifying to find that his opinion with regard to the necessity for further work on the ravages of this pest is fully justified by a very valuable contribution by A. Seymour-Jones, C.B.E., F.R.M.S., in the same volume. Mr. Seymour-Jones writes on "Warble Flies and their Maggots in Cattle," and his paper constitutes a very useful and interesting account of the life-history of the Warble Fly. It is enhanced by the drawings and photographs with which it is well illustrated.

The *Fruit Grower* of June 30th, 1921, contained an article from the pen of a member of our London technical staff, Mr. Theodore Parker, on "Chloropicrin Petroleum Emulsion as an Aphicide," and he recounts experiments on rats, grain beetles and other organisms. Some further results in connection with the value of Chloropicrin against *T. khapra* are embodied in his article in this number of the *Bulletin*. Also, in its issue of August 4th, that Journal contains some notes by the same author on "Phytophthora Infestans" on potatoes, and its control by spraying and dusting.

THE BIOLOGY OF LEATHER MANUFACTURE.



F. A. MASON.]

[Leather Trades Year Book, 1921.]

There are indications that "dry" spraying with fungicides and insecticides, which has been tried with considerable success in America, is gaining favour in this country, and in another article on "The Possibilities of Dry Spraying," contributed by Mr. Parker to *Modern Farming*, September, 1921, the question is further and more fully discussed.

The larvæ of the Meal Beetle referred to on page 79, *Bulletin* No. 3, pupated unobserved about the second week in July, and a beetle emerged on August 15th, which proved to be *Tenebrio molitor* L. In September we received another sample of malt from the London district containing half- and fully-grown specimens of the larvæ of the same beetle, and enquiries go to show that this insect is much more common in Maltings than has been supposed. It is perhaps more frequent in malt-culms than among the malt.

Another pest which has been found in large numbers in a Maltings in Essex is the Saw-Toothed Grain Beetle, *Silvanus surinamensis*. A sample of grain, as received by us, was literally alive with the larvæ, pupæ and beetles of this species, to the exclusion of all others.

Among other interesting cases of insect pests examined recently was the occurrence of the beetle *Niptus hololeucus* in all its stages in a sample of commercial casein. Before pupation the larvæ binds the granules of casein together into the form of small cells, about the size of a pill, but of an oval shape, which, in a granular quality of casein, easily pass undetected. Casein attacked by this insect possesses a disagreeable odour and is rendered unfit for food purposes.

Readers of the *Bulletin* will remember that on previous occasions we have referred to the occurrence of *Niptus hololeucus*, and *Nature*, in its issue of August 18th, publishes a letter from Professor

Hickson, of the Manchester University, in which a reference is made to the same insect. The letter clearly bears out our own experience, and it is so strong an argument for the necessity of more work in the direction insisted upon in the pages of the *Bulletin* from its commencement that we take the liberty of reproducing it. Professor Hickson, writing under the heading "The Neglect of Science," says :—

"A lady called on me to-day saying she had been sent by the sanitary inspector of a large town a few miles from Manchester with specimens of a little winged beetle (*Niptus hololeucus*), which she and the inspector thought might be bed bugs.

Is it not extraordinary that those who are placed in posts of great responsibility in sanitary matters are so ignorant of their job that they cannot distinguish a flat wingless bug from a harmless and almost spherical beetle?

I wonder how much money has been wasted in unnecessary fumigation and the destruction of bedding by the crass ignorance displayed by sanitary inspectors of the elements of the natural history of their calling."

We know something of the teaching of biological science to sanitary inspectors in classes removed from the influence of University training, and we are afraid there will have to be a good deal of improvement in the knowledge of the teachers themselves before the state of ignorance revealed is materially altered.

Owing to the rainy period which set in just at the time when the crops were ripe, particularly in the North of England, a good deal of grain began to sprout in the ear. Ears of barley have been examined in which 90 per cent. of the grain had germinated *in situ*. We have seen samples of barley showing a germination equal to four days' growth on the malting floors, the embryo end being fully modified and having all the characteristics of malt. The rootlets will be removed on threshing, and barley buyers for malting

purposes would do well to look out for signs of "growth in the field" when buying. Of two samples of malting barley received for examination, a Yorkshire sample gave Moisture 17.26 per cent., while a sample of Huntingdon barley, harvested without rain, gave 13.22 per cent. The Yorkshire sample germinated only 81 per cent., whereas the Huntingdon sample gave 99.8 per cent. germinating capacity.

Cav. Uff. Ettore Andreis, the well-known Italian leather technologist, writing on "La Bio-tecnologia e l'industria dei Cuoi" in *Rivista Italiana del Cuoio dei Pellami*, pays us a very high compliment in his reference to *Bulletins* Nos. 1, 2 and 3. His sentiments are practically impossible to reproduce in our prosaic English language. He compares the difficulties undertaken by Messrs. Murphy & Son, Ltd., in their researches into the invisible realms of leather technology with Lipeyronie's search for the soul, and speaks of the rock of safety constituted by Research in the Laboratory. He commends the publication of results in the form of a *Bulletin*, thereby assisting in the closer co-operation of labour and thought.

Mr. P. Hampshire, our Bacteriologist, has been re-appointed Lecturer in Bacteriology for the Session 1921-22, in the Technical Schools under the City of Leeds Department of Education.

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